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Assessment of the current state of populations and study of phytochemical features of *Conium maculatum* L. in the Ili-Alatau mountains

Abstract. A comprehensive study of the anatomical structure of the plant *Conuim maculatum* L. from the genus Ariaceae Lindl., which has valuable medicinal properties is presented. Currently, the medicinal plant *Conuim maculatum* L. is widely used in folk medicine. This plant is used by specialists for the prevention of various diseases, especially for the treatment of various types of cancer, as well as for the preparation of active painkillers and anti-inflammatory drugs. The article analyzes the current state of the plant *Conuim maculatum* L. in the Ili-Alatau, diagnostic signs were identified and the main features of its anatomical structure were analyzed. The article analyzes in detail the biological features of the medicinal plant *Conuim maculatum* L., the main promising distribution zones of the plant in the country, and also describes the systematic classification, phytochemical features and chemical structure of this species. Eco-phytocenotic features of *Conuim maculatum* L. are shown on a population growing at the foothills of the Ili-Alatau. The work on determining the chemical composition of the species *Conuim maculatum* L. was carried out at the research center of medicinal plants of the al-Farabi Kazakh National University.

Key words: *Conuim maculatum* L., botany, population, phytochemistry, anatomy, morphology.

Introduction

Currently, one of the pressing problems facing domestic scientists is the production of medicinal preparations necessary for medicine from plants with medicinal properties, increasing their effectiveness. Undoubtedly, the medicine made at the expense of medicinal plants has a number of advantages over synthetic ones [1,2]. This is due to the fact that phytopreparations obtained on the basis of medicinal plants are highly effective in the treatment of neglected diseases in the human body and cause minimal damage to the environment. Therefore, it is necessary to turn plants with medicinal properties into the main source of raw materials for the pharmaceutical industry, by integrating scientific work with practical work aimed at the systematic study of medicinal plants and the use of medicinal plants as raw materials for the production of medicines [3]. Inflammation as a pathological process is the most common form of the disease among people, the exacerbation of such diseases, the long-term persistence of symptoms of this disease in the human body leads to a decrease in the ability to work of a person, so the development of drugs to stabilize this problem is one of the most pressing issues today [4-6]. The flora of modern Kazakhstan includes about 6,000 plant species. Among them, more than 1,500 species of plants with healing properties have been registered. However, only more than 60 medicinal plants are officially included in the State Pharmacopoeia of the Republic of Kazakhstan, but despite this, such medicinal plants as *Conuim (C.) maculatum* L. require a full-scale systematic study [7]. This plant, which has a small source base, is used only in folk medicine for the treatment of inflammatory diseases, asthma, seizures and other diseases [8].

C. maculatum L. contains biologically active constituents of various chemical structures. Therapeutic effect of this plant on the human body is very large, as it is a part of the phenolic combined type, and a valuable medicinal plant in the fight against diseases and bacteria.

Recently, the range of application of *C. maculatum* L. significantly expanded, and now they are used not only in the treatment of rheumatological diseases, but also for the prevention of thrombosis in immunocompetent diseases and the prevention of the initial stage of atherosclerosis. They can be used in small operations, in the treatment of cardiovascular diseases, in oligomenorrhea, in Alzheimer's disease, in dementia and oncology. In particular, it is widely used for the prevention of colon cancer [9-11]. For

the localization of various malignant neoplasms, anti-inflammatory drugs act individually, the number of phytopreparations that act simultaneously in several aspects is limited in traditional and official medicine. Numerous data shows that it has a pronounced effect on many models of the disease, more effectively than other synthetic drugs. For example, with the help of histamine, serotonin, dextran, formalin, egg white, acetylsalicylic acid or phenylbutazone, you can quickly, but not for long, relieve edema, and in the fight against slow-developing and prolonged inflammation (kaolin, carrageenin) [11,12].

The plant itself contains up to 1-2% of the alkaloid, the alkaloid content in the leaves – 0.1 %, in the flower – 0.24 %, a large amount of the alkaloid is contained in the seeds – 1.6% and essential oil and caffeic acid – 0.08% [13-15].

The purpose of the current research is a systematic study of the biological, anatomical features of this rich in alkaloids medicinal plant and the study of the areas of its distribution.

Materials and methods

Object of research. Four species of the hemlock family Conium L. (Apiaceae Lindl.) are widely distributed in Europe, Siberia and Asia Minor, including Kazakhstan [16-18]. *Conium Maculatum* L. a two-year-old plant, reaching 2 m in height, blooms in May-June and bears fruit in June-July. Such a plant grows like a weed and they can often be found at the foot of roads, in the garden, on the slopes of mountains, in meadows in all regions of the republic, except for the desert [19,20].

All parts of the plant are poisonous and have an unpleasant smell due to the presence of an alkaloid in them. The fruits of the plant contain up to 2% alkaloid, coniin, coumarin, flavonoids, monoterpenoid and hydrocarbons, etc. [21,22]. The population materials were collected in the Almaty region, Karasai district, the foothills of the Zailiysky Alatau, and Raiymbek rural district. Coordinates above sea level: H = 860 m, N = 4311’201”, E=07642’202”.

Methods of research. The objects of the study were the vegetative organs (root, stem, leaf) *C. maculatum* L. (Apiaceae Lindl.). Samples of plant raw materials-spotted hemlock were collected in August 2020, during the flowering period, in the foothills of the Trans-Ili Alatau, Almaty region.

An anatomical study was performed on the fixed material. Cross-sections of roots, stems and leaves were prepared manually and with the help of a microtome on the TOS-2 freezing device [24-26]. The object was covered with a cover glass, viewed from both sides under a microscope, first at a small (x 100), then at a large (x400) magnification using an Olympus BX41 microscope. Photography was carried out using the LOMO DCM 800 camera using the technique of microscopic examination of medicinal plant raw materials at the laboratory of Plant Anatomy and Morphology, Al-Farabi Kazakh National University [27].

In the manufacture and description of the preparations, the methods generally accepted in plant anatomy were used. In the process of research methods were used freezing M. Prosimy and R. Barykina. Geometric calculations are obtained by the method of R. Barykina [28,29].

When analyzing the data obtained, statistical processing was used, using the Microsoft Office software package.

Results and discussion

The leaves of *C. maculatum* L. are arranged alternately, the lower leaves are three times pinnate (resemble a parsley leaf) and reach a length of 30-60 cm [30]. The flowers are small, white, with the inner side collected in bundles of about 12-20 flowers. The seed is ovate, light brown dioecious, slightly compressed from the side. The stem is 60-180 cm high, branched, curved, hollow, with some places bluish, the lower part is covered with reddish-brown spots, because of these spots and is called «spotted» (Figure 1). In the first years of the growing season, the roots begin to develop well, from the second year the stem develops [31].

On the surface of the root of *C. maculatum* L. there is a 1-2-row layer of exoderm. The cells of the exoderm have an elongated rectangular shape, are tightly connected and strongly elongated in the radial direction. The parenchyma of the primary cortex is represented by several layers (4-6) of round-elongated cells with slightly thickened walls without intercellular cells. In the cells of the primary cortex, there are multiple inclusions that give the section a certain granularity of this topographic zone. The phloem is located in small areas between the central vessels of the xylem. The cambium is represented by a single-row layer of rather small cells. The xylem is represented by numerous broad-colored vessels converging to the center, as well as fibers and small cells of the parenchyma (Figure 2). The morphometric parameters of the roots are presented in Table 1.

a b

Figure 1 – The general appearance of cultivated specimens. Note: a-the upper part of the inflorescence during flowering; b-the upper part of the inflorescence in the phase of the beginning of fruiting

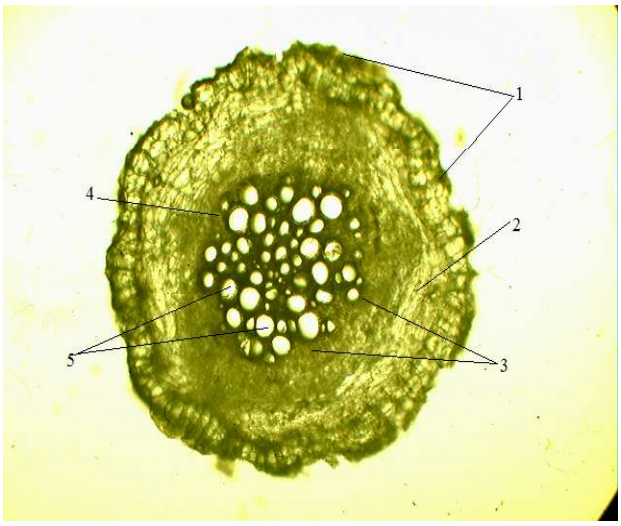

Figure 2 – Anatomical structure of the root of *C. maculatum* L. (x100)
1-exoderm, 2-primary cortex, 3-phloem, 4-cambium, 5 – xylem vessels

Table 1 – Morphometric parameters of the roots of *C. maculatum* L.

Exoderm layer thickness, μm	Primary crust thickness, μm	Central cylinder diameter, μm	Area of xylem vessels, $x10^{-3}mm^2$
0,55±0,150	17, 84±2,215		0,29±0,170
0,63±0,290	17, 90±2,110		0,20±0,110
0,30±0,180	17,95±2,513	8,464±3,110	0,10±0,09
0,40±0,160	14,87±2,414		0,11±0,09
0,35±0,210	15,05±3,110		0,17±0,120
average values			
0,446±0,198	16,722±2,418	8,464±3,110	0,174±0,116

The thickness of the exoderm layer averaged 0,446±0,198 μm, the thickness of the primary cortex 16,722 ± 2.418 μm, the diameter of the central cylinder 8,464±3,110 μm, and the area of xylem vessels 0,174±0,116x10^{-3} mm^2.

When considering the cross-section of the stem of *C. maculatum* L. (Figure 3) on the surface, a fairly tightly closed layer of epidermal cells is visible. The primary cortex is externally bounded by a 1-2-ply epidermis, followed by the angular collenchyme (the stem morphologically has significant surface ribbing) and the parenchyme.

As can be seen from the Figure 3, the collenchyme is mainly located in the ribs (5-7 rows), and the cells of the cortical parenchyma are located in 2-3 rows. Parenchymal cells have a rounded shape, thin-walled. Conducting beams of medium size. The primary phloem consists of thin-walled sieve-like elements and accompanying cells. The primary xylem occupies the inner part of the bundle, represented by 7-15 medium-and wide-light vessels. Along the entire circumference of the stem, a pronounced sclerenchymal lining is located above the launches. The xylem is surrounded in some places by tightly closed sclerenchyma cells. The cells of the heart-shaped parenchyma are numerous, have a rounded shape, and are thin-walled. In the stem, inclusions are noted in the areas of the conducting bundles and the primary cortex. The core is gradually destroyed, and an air-bearing cavity is formed in its place.

The morphometric parameters of the stem are presented in Table 2.

Figure 3 – Anatomical structure of the stem (x100).
Note: 1-epidermis, 2-collenchyma, 3-chlorophyll-bearing parenchyma, 4-sclerenchyma, 5-xylem vessels, 6-core parenchyma, 7-air-bearing cavity

Table 2 – Morphometric parameters of the stem *C. maculatum* L.

Thickness of the epidermis, μm	The thickness of the primary cortex, μm	Thickness of the sclerenchyma layer, μm	Diameter of the central cylinder, μm
0,68±0,265 0,55±0,314 0,82±0,221 0,90±0,317 0,110±0,289	1,386±0,902 1,381±0,874 1,436±0,800 1,385±0,599 1,276±0,562	0,674±0,102 0,773±0,147 0,942±0,196 0,778±0,152 0,805±0,143	24,173±2,265
average values			
0,612±0,281	1,373±0,747	0,794±0,148	24,173±2,265

From Table 2, it can be seen that the thickness of the epidermis layer on average was 0,612±0,281 μm, the thickness of the primary cortex was 1,373±0,747 μm, the diameter of the central cylinder was 24,173±2,265 μm, and the thickness of the sclerenchyma layer was 0,794±0,148 μm.

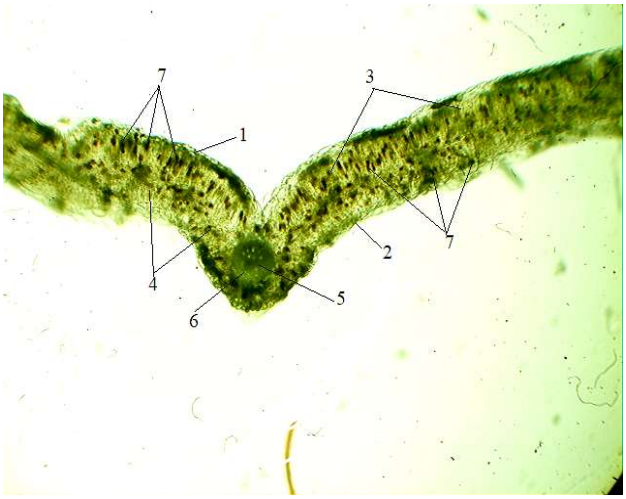

Figure 4 – Anatomical structure of the leaf *C. maculatum* L. (sw.x100).
Note: 1-upper epidermis, 2-lower epidermis, 3-chlorophyll-bearing columnar parenchyma, 4-spongy parenchyma, 5-conducting bundle, 6-sclerenchyma cells, 7-inclusions

Table 3 – Morphometric parameters of the leaves *C. maculatum* L.

Thickness of the epidermis, μm	Thickness of the mesophyll layer, μm	The thickness of the columnar mesophyll,μm	The thickness of the spongy mesophyll,μm	The area of the conducting bundles, x10^{3}мм^2
0,063± 0,05	0,780± 0,12	0,482± 0,15	0,296± 0,13	0,357± 0,20
0,050± 0,06	0,926± 0,15	0,475± 0,15	0,519± 0,1	0,310± 0,18
0,070± 0,02	0,955± 0,18	0,325± 0,19	0,305± 0,11	0,248± 0,11
0,090± 0,03	0,970± 0,17	0,494± 0,09	0,410± 0,14	0,470± 0,20
0,131± 0,03	0,982± 0,22	0,536± 0,10	0,407± 0,14	0,260± 0,16
average values				
0,081± 0,038	0,922± 0,168	0,462± 0,136	0,387± 0,124	0,329± 0,17

From the surface, the leaf blade of *Conium maculatum* L. is covered with a thin layer of cuticle. Weak wrinkling is visible on both sides of the sheet. The cells of the upper epidermis have a lesser degree of tortuosity than the cells of the lower epidermis. The cells have thin walls. Columnar chlorophyll-bearing parenchyma is represented by two rows of densely spaced oblong cells with numerous inclusions. The lower part of the mesophyll is represented by 2-3 layers of cells and consists of a loose spongy parenchyma, and numerous inclusions are also noted. The cells of the columnar mesophyll have an average size of 0,462±0,136 microns, and the spongy mesophyll 0,387± 0,124 microns. The median vein of the leaf has a sclerenchymal lining. Smaller conducting bundles of the leaf in the number 2-4 of the collateral are closed. The area of the conducting beams is 0,329=0,17x10^3 mm^2. There is one secretory channel between the sclerenchyma and the corresponding conducting beam (Figure 4). The morphometric parameters of the leaves are presented in Table 3. Thus, on the basis of the morphological and anatomical study, basic structural features of *C. maculatum* L. were revealed.

Conclusion

Work on the definition of the anatomical structure of the species *Conuim Maculatum* L. conducted in the research center of medicinal plants of the Al-Farabi Kazakh National University. According to the purpose of the work, by studying the anatomical structure of the plant hemlock spotted (*Conium maculatum* L.) belonging to the family *Apiaceae* Lindl. diagnostic signs were identified, the place of biologically active components in the cell was determined. As a result of studying the anatomical structure of the plant, it was found that the plant leaf is covered with thin cuticles, and the lower part of the mesophyll consists of a loose spongy parenchyma and a 2-3-layer cell. On a cross-section of the stem of the plant *Conium maculatum* L. clearly visible, tightly closed layer of epidermis cells. The presence of a 1-2-row layer of rectangular ectoderm in the root bundle was established, the parenchyma of the first root bundle cortex consists of several layers (4-6).

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References

1 Gemedzhieva N.G. (2009) Izuchenie i sohranenie bioraznoobraziya alkaloidonosnyh rastenij Kazahstana [Study and conservation of the biodiversity of alkaloid-bearing plants in Kazakhstan] // Vestnik KazNU. Seriya biologicheskaya, no. 1, pp. 5-14. https://bb.kaznu.kz/index.php/biology/article/view/31

2 Vetter J. (2004) Poison hemlock (Conium maculatum L.) // Food and Chemical Toxicology, vol 43, issue 9, September, pp. 1373-1382 https://doi.org/10.1016/j.fct.2004.04.009

3 Holm L., Doll J., Holm E., Pancho J., Herberger J. (1997) World weeds, natural histories and distribution. New York, 1152 p. ISBN 978-0-471-04701-8

4 Vickery M. (2010) Plant poisons: their occurrence, biochemistry and physiological properties // Science Progress, 93(2), pp. 181–221 https://doi.org/10.3184/003685010X12729948220326

5 Saeedeh Nury, Ahmad Hosseini, Adrian J. Gibbs, Musa Mohammadi (2020) Poison hemlock virus Y (PHVY), a novel potyvirus from Iranian Conium maculatum L. (Apiaceae Lindl.) // Australasian Plant Pathology, 17 January, pp. 119-126 https://doi.org/10.1007/s13313-020-00681-0

6 Budancev A.L., Lesiovskaya E.E. (2001) Dikorastushchie poleznye rasteniya Rossii [Wild-growing useful plants of Russia]. SPb., 663 p. ISBN 5-8085-0124-5

7 Brtalik D., Stopyra J., Hannum J. (2017) Intravenous poison hemlock injection resulting in prolonged respiratory failure and encephalopathy // Journal of Medical Toxicology, vol. 13, pp. 180-182 https://doi.org/10.1007/s13181-017-0601-0

8 Seegmiller W.H., Graves J., Robertson D.J. (2020) A novel rind puncture technique to measure rind thickness and diameter in plant stalks // Plant Methods, vol. 16, pp. 43-45 https://doi.org/10.1186/s13007-020-00587-4

9 Madaan R., Kumar S. (2012) Screening of alkaloidal fraction of Conium maculatum L. aerial parts for analgesic and antiinflammatory activity // Indian J. Pharm Sci, vol. 74, issue 5, September, pp. 457-460 https://doi.org/10.4103/0250-474X.108423

10 Zholondz M.Y. (2001) Rak: praktika iscelenie [Cancer: practice and healing]. SPb., 192 p. ISBN 978-5-49807-564-8

11 Mahlayuk V.P. (1993) Lekarstvennye rasteniya v narodnoj medicine [Medicinal plants in folk medicine]. Saratov, 544 p. ISBN 5-7633-0743-7

12 Chevallier A. (1996) The Encyclopedia of Medicinal Plants. DK Pub, 336 p. ISBN 0789410672

13 Mitich W.L. (1998) Poison-hemlock (Conium maculatum L.) // Weed Technology, vol.12, is. 1, March, pp. 194-197 https://doi.org/10.1017/S0890037X00042792

14 Kingsbury J. M. (1964) Poisonous plants of the United States and Canada// Science, 25 September, vol. 145, issue 3639, pp. 1425-1426 https://doi.org/10.1126/science.145.3639.1425-a

15 Cromwell B. T. (1956) The separation, micro-estimation and distribution of the alkaloids of hemlock (Conium maculatum L.)// Biochem, 64(2), pp. 259–266 https://doi.org/10.1042/bj0640259

16 Flora SSSR (1950). Tom 16 [Flora of the USSR. Vol. 16]. Moskva, pp. 225-229 ISBN 978-5458419918

17 Flora, rastitel'nost' i rastitel'nye resursy Kazahstana (2006) [Flora, vegetation and plant resources of Kazakhstan]. Almaty, 217 p. ISBN 9965-473-87-0

18 Atlas arealov i resursov lekarstvennyh rastenij SSSR (1983) [Atlas of areas and resources of medicinal plants of the USSR]. Moskva, 268 p. ISBN ВВН 0531-БН2-020818-07

19 Gemedzhieva N.G. (2012) Alkaloidonosnye rasteniya Kazahstana i perspektivy ih ispol'zovaniya

(na primere Dzhungaro-Severotyan'shan'skoj provincii) [Alkaloid-bearing plants of Kazakhstan and prospects of their use (on the example of the Dzungaro-North Tianshan province)]. Almaty, 312 p. ISBN 978-601-80287-0-0

20 Gemedzhieva N.G. (2009) Osobennosti biologii Conium maculatum L. v predgor'yah Zailijskogo Alatau [Biological features of Conium maculatum L. in the foothills of the trans-Ili Alatau] // Izvestiya NAN RK. Ser. biol. i med, Almaty, no. 2, pp. 24-27 http://library.kz/ru/menuvse/119-journalsnanrk/2010-10-03-11-53-53/484-2009-2

21 Bowman C., Snaghvi S. (1963) Pharmacological actions of hemlock (Conium maculatum L.) alkaloids // Journal of Pharmacy and Pharmacology, vol. 15, pp. 1–25 https://doi.org/10.1111/j.2042-7158.1963.tb12738.x

22 Karzhaubekova Zh. Zh., Gemejyieva N. G., Arisbaeva R. B. (2016) K soderzhaniyu efirnyh masel u dikorastushchih vidov gornyh hrebtov Yugo-Vostoka Kazahstana [The content of essential oils in wild species of mountain ranges in the South-East of Kazakhstan], vol. 65, no. 3, sep., pp. 34-39 https://bb.kaznu.kz/index.php/biology/article/view/1093

23 Isachenko A.G. (1998) Metody polevyh landshaftnyh issledovanij i landshaftno- ekologicheskoe kartografirovanie [Methods of field landscape research and landscape-ecological mapping]. SPb., 112 p. ISBN 5-288-02079-5

24 Bar'kina R.P., Veselova T.D., Devyatov A.G., Dzhalilova H.H. (2004) Spravochnik po botanicheskoj mikrotekhnike. Osnovy i metody [Reference book on Botanical micro-technology. Basics and methods]. M:. MGU, 312 p. ISBN 5-211-06103-9

25 Biryuzova V.I., Borovyagin V.L., Gilev V.P. (1963) Elektronnomikroskopicheskie metody issledovaniya biologicheskih ob"ektov [Electron microscopic methods for studying biological objects]. M.: Izd-vo AN SSSR, 204 p. ISBN KAE 122-08022019-24

26 Vasnecova O. A. (2009) Medicinskoe i farmacevticheskoe tovarovedenie. Tom 2 [Medical and pharmaceutical commodity science. Vol. 2]. M. : Geotar-Media, 608 p. ISBN 978-5-9704-1106-3

27 Polevoj V.V. (1989) Fiziologiya rastenij [Plant physiology]. M.: Vysshaya shkola, 484 p. ISBN 5-06-001604-8

28 Bajtenov M.S. (2001) Flora Kazahstana. Tom 2 [Flora of Kazakhstan. Vol. 2]. Almaty: Gylym. ISBN 9965-07-036-9

29 Da Cheng Hao, Xiao-Jie Gu, Pei Gen Xiao (2015) Medicinal Plants. Woodhead Publishing, 694 p. ISBN 978-0-08-100085-4

30 Tahaeva M., Amankulova B. (2006) Flora, rastitel'nost' i rastitel'nye resursy Kazahstana [Flora, vegetation and plant resources of Kazakhstan]. Almaty, 217 p. ISBN 9965-473-87-0

31 Dodd-Butera T., Broderick M. (2005) Plants, Poisonous // Encyclopedia of Toxicology, pp. 443-448 https://doi.org/10.1016/B0-12-369400-0/00771-7